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BIOLOGICAL CONSIDERATIONS OF DENDROCTONUS BREVICOMIS IN THE NORTHFORK REGION OF CALIFORNIA

1932-33

by

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BIOLOGICAL CONSIDERATIONS OF DENDROCTONUS BREVICOMIS IN THE NORTHFORK REGION OF CALIFORNIA, 1932-33

The following are a few life-history notes on Dendroctonus brevicomis, as evidenced by infested trees near Northfork, Calif. The prime consideration was to determine the number of generations that might be developed by the western pine beetle in this area. A few additional biological notes are also given, mostly dealing with early and late development of broods.

Person[1] in 1926 at Cascadel, in this same general locality, found D.brevicomis to have three generations. His method was the usual one of observing a series of brood trees throughout the summer. In such a series any given stage, attack for instance, will be occurring constantly throughout the summer. A graph representing seasonal attacks, based on many records for an area, would be wave-like, the crests representing periods of maximum attack and the troughs scattered attack by overlapping brood or broods not conforming to the main infestation. By grouping such a series of observations, a number of average-length generations can be calculated for any desired period. This is an accurate method of determining the number of generations for most of the beetles on an area. However, care must be exercised in following the same portion of the same stage throughout; i.e., first attack to first attack, maximum attack to maximum attack, and the like.

It is known that there is considerable difference between the average and the minimum length of the life cycle for D.brevicomis. Working on the supposition that the probabilities for the development of infestations might lie in the direction of the shorter life cycle rather than the average, it was decided to make a study of the potential development of this insect. For this purpose development of broods was followed from tree to tree in a single locality. Manzanita Lake, at an elevation of approximately 3,000 feet, was chosen, and four trees in all observed, each representing a life cycle. Graph No. 1 represents the development in these trees.

Seasonal Development Shown by the Manzanita Lake Brood Trees

Tree No. 1

The fall of 1931 allowed the beetles to develop until about November 19 (Gustafson[2]). Evidently the brood in this tree was advanced at least to the large-larval, or more probably to the new-adult stage, by the time winter caused activity to stop. The amount of development during the winter is problematical; but it is known that D. brevicomis begins activity whenever the bark assumes a certain temperature--around 50° F. Winter activity will be discussed more at length later.

At any rate, most of the beetles from Tree No.1 had emerged prior to May 5, probably between April 15 and May 5, possibly earlier. That beetles were in flight and attacking as early as April 15 is certain, because in the Chiquito Basin Control Area, at an elevation of 4,000 feet, new attacks and newly-abandoned trees were considerably in evidence by this date. Accordingly it is safe to say that the Manzanita Lake area, in the same general region and at a thousand feet lower elevation, would be at least as far advanced as the Chiquito country.

Tree No. 2

This tree was newly attacked on May 5, at the time of the first examination. These attacking beetles might have come from Tree No. 1, although it is readily admitted that this was not necessarily the case. The point is that either beetles from Tree No. 1 or beetles emerging from some other tree at the same time caused the attack on Tree No. 2.

Throughout this study it will be noted that emergence and attack are considered as occurring very nearly simultaneously. Keen[3] from cruising data calculated a flight period of 26 days, although his diagrams show that emergence and attack occur concurrently.

It is just as reasonable as not to assume that the adultsattack soon after emergence. They have not been observed to have feeding habits similar to Phloeosinus, which frequently girdles small twigs between the time of emergence and that of egg laying. Struble[4] caged several hundred D.brevicomis adults on a small ponderosa pine sapling. These beetles attempted to construct egg galleries near the base, but there was no evidence of feeding, on the needles or otherwise.

In caging newly-emerged adults on green standing trees there is an interval of one to several days before attack occurs--usually two. Miller, Person and others have noted this. This reluctance in attacking the caged tree may not be due to any immature nature of the beetles, but rather to the non-attractive nature of the tree itself. There is considerable evidence from field observations that the beetles do not usually attack in the immediate vicinity of the trees from which they emerge. This necessitates a flight period of longer or shorter duration. However, since caging experiments show that only a short time is necessary between emergence and attack, the two are considered as occurring at approximately the same time, with a slight lag between peak of emergence and peak of attack.

To continue with Tree No. 2: on May 5, at the time of the first observation, the attack in this tree was not more than a week old, with new attacks still being made and some eggs already present. By June 20 this tree was nearly abandoned except at the very base, where straggling brood continued to emerge until about July 20. Thus Tree No. 2 represents the completion of the first life cycle in 1932.

Tree No. 3

The period of attack on Tree No. 3 very nearly coincided with the maximum emergence from Tree No. 2. The initial attack occurred approximately June 25. By June 27 attack was very heavy. Here again the beetles may not have come from Tree No. 2, but the fact remains that they could have. Following through this second life cycle, most of the brood had emerged between the 10th and 15th of August.

Tree No. 4

No further observations were made in this area until November 1, when Tree No. 4, about 100 yards from 1, 2 and 3, was recorded as having approximately 25% emergence. The intervening period between August 15 and November 1 was certainly long enough to account for the development of a third life cycle, inasmuch as effective developmental temperatures occurred daily during that period. Indeed, probably too long a period has been allowed for this life cycle, but the lack of observations prohibited a closer tying-in of records.

Only a portion of the beetles from Tree No. 4 emerged and attacked in the fall of 1932. The rest overwintered and will emerge during the spring of 1933. That a very distinct generation occurred on approximately November 1, 1932, is certain from a number of trees observed in the same vicinity containing new attacks, eggs and small larvae.

The period of development in the fall of 1932 was nearly a month longer than in 1931 (Gustafson[5]). Development in 1931 stopped around November 10, while that in 1932 did not cease until December 9. This gave the attacks initiated around the first of November 1932 ample time to develop into fair-sized larvae before winter set in. This plus spring development in 1933 will very nearly round out four complete life cycles when tied in with Tree No. 1.

It must be kept in mind that all the beetles on the area were not able to produce four generations; in fact, probably most of them were unable to do so. However, it is felt that perhaps under epidemic conditions a larger proportion of beetles may pass through a greater number of generations. The importance of increasing the number of generations of an insect is well known and need not be discussed here.

Trap Tree Data

Generations in standing trees are rather difficult to limit definitely, so the development of D.brevicomis in a trap tree felled in the Manzanita Lake area may be of interest. In general, the rate of development in trap trees has been shown to be slower than in standing trees (Beal[6]), so the following figures for rate of development should not be excessive.

A medium-sized ponderosa pine was felled May 5 and on May 11 two attacks were noted, just penetrating to the inner bark. Attack could not have been over a day old. Very nearly all the beetles had

developed and emerged by July 11, with only a few new adults left. This represents a period of development of two months, although correctly the time should be figured from say maximum attack to maximum emergence, which would give a somewhat shorter period.

However, taking a developmental period of two months, and dividing this into the length of the growing season, April 15 to December 9--a period of eight months--we get roughly four generations as in the case of the four standing tree records. Since the brood developed during the first part of the growing season, it was probably as slow as any during the season would be.

In all, 18 trap trees were felled throughout the early and middle portions of the summer. Eight of these, varying from 8 to 18 inches in diameter, were unattacked by D.brevicomis. This may have been entirely due to the unattractive nature of the traps, or partially due to the declining status of the infestation on the area.

Of the remaining ten trees, six were attacked by D.brevicomis but were unable to produce successful brood. One of these trees which was attacked extremely heavily contained developing brood for 70 days before complete brood failure was recorded at about the half-grown larval stage. This single example was undoubtedly a case of overcrowding.

Four trap trees produced mature brood in fair numbers. From initial attack to initial emergence these logs varied from 48 to 62 days, with an average of 56 days. A difference in elevation of 2,000 feet could not be demonstrated as having an effect upon the length of development in the traps.

Additional Brood Tree Data

Five standing trees developed brood from first attack to first emergence in 48 to 56 days, with an average of 51 days. The same five trees exhibited maximum emergence in 51 to 61 days, with an average of 56 days. Person at Cascadel in 1926 found that six trees averaged 45 days from first egg to first emergence, which very nearly coincides with our figures when a week is added for the development of the first egg.

One 1931 D.brevicomis topkilled tree yielded interesting data. Starting in the spring of 1932 the base was entirely green. About April 27 the south side filled in with D.brevicomis. Initial emergence from this side occurred June 20, a period of 54 days. The north side did not fill in until May 11. Initial emergence from this side occurred July 5, also a period of 56 days. From this it can be seen that care must be exercised in attributing differences in brood on north and south sides wholly to differences in rate of development. Undoubtedly difference in time of attack plays an important part in late fall and early spring attacks.

Keen has noted that D.brevicomis holds over in the north side at the base of overwintering brood trees much longer than in the case of summer-generation trees. This contrast was nicely illustrated by three of the brood trees which were studied. Two of these trees were winter trees of 1931. On May 5 and 12, 1932, these trees were practically abandoned except for a little brood at the base on the north side of each. These small basal areas were not completely abandoned for 68 and 49 days respectively. On the other hand, a 1932-summer generation tree, practically abandoned on July 20, took only 21 additional days for the north side to become totally abandoned.

Fall, Winter and Spring Records

Twenty-one trees were studied which had some bearing upon either the late or the early development. Three sets of observations were taken--late fall, very early spring and April--although every tree was not examined three times. The accompanying chart shows exactly how each tree varied or did not vary from one examination to the next.

Two 1932 D.brevicomis topkills were not filled in by March 9 and April 11, 1933, respectively. It is felt that had there been any considerable amount of emergence up to that time, these two trees would have been very likely to pick up the infestation. A follow-up of these trees will show whether they do actually pick up early 1933 infestation.

Between October 31 and November 3, 1932, seven trees showed no attack (1 tree), eggs or small larvae. By March 9-10, 1933, the predominant stage was in all cases large-larval. A few pupae on the south side of two trees and eggs overwintering on the north side of two trees offered the variations. On April 11-12, 1933, only five of these trees were examined, but all contained some pupae and one a few callow adults.

The remaining 13 trees were all more advanced in the fall. All showed evidence of development between October 31, 1932, and April 12, 1933. Six trees showed emergence; five, new adults; and eight, pupae. Some of course showed development of two or more stages. The method of sampling may have led to some error in the case of emergence, but the formation of pupae and the subsequent development of new adults was undoubtedly a spring process, since overwintering pupae are very rare with this species.

It will be noticed that the younger stages have a tendency to catch up with the older stages during the winter. For instance, a number of trees containing small larvae in the fall came out in the spring with large larvae and pupae, much as did trees which entered the winter with large larvae. That these broods do not become exactly equalized is true, but there is a tendency in that direction.

In comparing the rate of brood development breast high and at ten feet on a number of trees, it was noted that the larger the tree the more likely it was that brood conditions would be similar in the two areas. This point should be of some little importance in selecting brood trees.

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Bass Lake, Calif.,
May 15, 1933.

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GRAPH SHOWING THE DEVELOPMENT OF D. BRUNNEUS IN WOOD TICKS

AT WAHKANITA LAKE - SEASON 1932-33

1931-32	1932	1932	1932	1932	1932	1932	1932	1932	1932	1933	1933	1933	1933
Winter	April	May	June	July	August	September	October	November	December	January	February	March	April
20	10 20	10 20	10 20	10 20	10 20	10 20	10 20	10 20	10 20	10 20	10 20	10 20	10 20

(Tree No. 1)

Overwintering broods to emergence of new adults

(Tree No. 2)

Initial Attack to Abandonment - 83 days

" Height of Emergence - 53 days

" Initial Emergence - 48 days

(Tree No. 3)

Initial Attack to Abandonment - ± 80 days

" Height of Emergence - 52 days

" Initial Emergence - 46 days

(Tree No. 4)

Initial Attack to Fall Emergence - ± 70 days

(Partial 4th Generation)

LIST OF BROOD RECORD TREES, SHOWING FALL AND SPRING DEVELOPMENT, SEASON 1932-33

BR-17 Ips top Db fill-in	8/ 8/32 15-25 Few Db attacks, pitched out; base green	3/9/33 N side - some emergence; mostly new adults, many mature larvae; no pupae; brood fair. S " - Precupal f.h. larvae	4/12/33 N side mostly abandoned; few undernourished mature larvae. S " fungus conks; no Db.
BR-30 Db top Base green	11/ 1/32 Foliage sorrel to fading; few unsuccessful Db attacks at base	3/9/33 Foliage red; woodpecker work 20' and up (Db) Base still green between unsuccessful attacks	4/--/33 No record
BR-34 Db tree	10/31/32 Db small larvae, half in phloem half just penetrating outer bark;	3/9/33 Fully mature larvae all sides at base	4/12/33 Brood in ½-1 larval, and pupal stages; about 10% pupae; all sides at base
BR-35 Db tree	10/31/32 Db, egg stage; many pitched out	3/9/33 Db brood development mostly unsuccessful; few large larvae; All sides at base	4/12/33 Brood in ½-1 larval, and pupal stages; about 10% pupae; all sides at base
BR-36 Db tree	10/31/32 Db small larvae in phloem; a few eggs on N side	3/9/33 Db large larvae only All sides at base	4/12/33 Brood in ½-1 larval, and pupal stages; about 10% pupae All ground
BR-41 Db tree	11/ 1/32 S base: mostly pupae, some larvae and NAs: 25% emergence N base: mostly large larvae, rest pupae; no NAs or emergence	3/10/33 Approx. 50% emergence; a number of mature larvae and a few pupae present	4/--/33 No record
BR-42 Db tree Felled	11/ 2/32 Brood mostly large larvae and pupae; few NAs and slight emerg.	3/ 9/33 S--approx. 50% emerg.; numerous large larvae and NAs, some pupae N--no emerg.; mostly large larvae, some NAs and an occasional pupa	4/11/33 N and under sides: mature larvae, pupae, NAs; no emergence S and top sides: one pupa and several NAs observed; emergence 90%.
BR-43 Db tree	11/ 2/32 Db larvae, pupae and NAs with slight emerg..mostly pupae:base	3/ 9/33 Heavy emergence, 2 pupae and fair number of large larvae Base	4/11/33 S and W sides; emergence completed; N and E sides, 60% emergence; remaining brood, large larvae, pupae and NAs
BR-44 Db tree	11/ 2/32 S side, egg stage only. N side, mostly green, few attacks just penetrating bark	3/ 9/33 S side: brood light, ½-1 larvae; few PAs, still alive N " : PAs overwintered: egg stage; green between attacks	4/--/33 No record
BR-45 Db tree	11/ 2/32 Db ½-1 larvae all around; same at 10' but more full-grown larv.	3/ 9/33 S base: full-grown larvae, pupae. N base: ½-1 larvae only. 10' N side: mature larvae. 10' S side: mature larvae and pupae	4/12/33 E,S,W sides 95% pupae, 5% larvae; N side about 90% mature larvae, 10% pupae
BR-46 Db tree	11/ 2/32 Db small to half-grown larvae, All sides	3/9/33 N base--½-1 larvae; E base--mature larvae; W and S bases--mostly mature larvae, many pupae; no NAs or emergence; 10' W--mature larvae, few pupae, no NAs or emergence	4/12/33 S base--75% pupae, 25% callow adults; no exit holes. N " --90% mature larvae, 10% pupae.
BR-47 Db tree	11/ 2/32 S & W base--Db very small larvae mostly in phloem; N & E base, egg stage only	3/9/33 W base--mature larvae; S base--mat. larvae and many pupae; E base--½-1 larvae; N base--eggs, PAs.	4/--/33 No record
BR-48 Db tree	11/2/32 W 10'--½-1 larvae, few pupae; base--small-½-grown larvae	3/9/33 SSW base--mature larvae only; NSE base--½-1 larvae; 10' N--mature larvae	4/12/33 S base--50% pupae, 50% larvae N " --Brood all ½-1 larvae
BR-49 Db tree	11/2/32 N base--eggs 50%, sm.larvae 50% S " --½-¾-gr.larvae; 10' S side--½-¾-grown larvae	3/9/33 N base--½-¾-grown larvae; S base--mostly large larvae, some pupae S 10'--mostly large larvae, some pupae	4/12/33 S and W base--90% NAs, 10% pupae; E and N " --larvae 90%, pupae 10%
BR-50A Db tree	No fall records	3/9/33 S base--large larvae and pupae, nearly 50% pupae; N base--½-1 larvae, mostly ½-grown	4/12/33 S base--mostly pupae, some NAs; N base--mostly large larvae, few pupae
BR-52 Db tree	11/2/32 Base--mature larvae	3/9/33 S base--considerable emergence, scattered mature larvae, some pupae; N 10'--large larvae only; no emergence	4/11/33 S base--abandoned N " --75% pupae, 25% mature larvae
BR-53 Db tree	11/3/32 Base--mostly large larvae, some pupae	3/9/33 N base--slight emergence; remainder, 75% lg. larvae, 25% NAs; E 10' same as N base; S base--slightly more emerg.than N; brood mostly large larvae, rest NAs.	4/11/33 All sides--40% NAs, 45% pupae, 15% mature larvae; very few exit holes
BR-54 Db tree	11/3/32 Db ½-1 larvae, all around	3/9/33 S base--fair emergence, ½-1 larvae, some pupae; no new adults; S 10'--same as S base; N base--½-1 larvae only	4/11/33 S base--mostly NAs, some pupae and large larvae. 5-10% emergence; N " --75% pupae, 25% mature larvae
BR-54A Db tree	11/3/32 Db ½-1 larvae, all around	3/9/33 S base--nearly all pupae, rest large larvae; N base--½-¾-gr. larvae only	4/11/33 S base--NAs mostly, some pupae and large larvae, 5-10% emergence; N " --60% mature larvae, 40% pupae
BR-55 Db tree	11/2/32 Examined by Wagner and Furniss; no indication of attack	3/9/33 N base--½-1 larvae	4/11/33 N base--85% pupal stage, rest full-grown larvae
BR-55A Db--top	11/2/32 Examined by Wagner and Furniss; no indication of attack	3/9/33 Sorrel to fading foliage; basal bole green; no attack	4/11/33 Foliage sorrel; basal bole green; no attack